ribs scattered among them. We think these also probably belong to *Loxomma.* There are fourteen or fifteen vertebræ; but, unfortunately, little can be made out respecting them except the form and character of the bodies, the processes of which are not determinable, though they seem mixed up with the matrix, which is partly composed of iron-pyrites.

The largest vertebræ are about seven-eighths of an inch wide, and five-eighths of an inch long; they are slightly hollowed at the ends, with the margins a little reflected; there is a minute notochordal foramen in the centre; but this is not always visible; and the sides are hollowed or channelled, but do not exhibit much striation.

The ribs are peculiar in form; they are about five inches long, but we cannot be certain that they are entire; the shaft is three-eighths of an inch wide, and is not much compressed; nor do they exhibit the longitudinal groove so usual in the ribs of these Amphibians. The proximal extremity is exceedingly wide, measuring across seven-eighths of an inch; it is much compressed; but the capitular margin is thick and continues the curve of the shaft; it projects a little beyond the tuberculum, and is divided from it by a very shallow notch; the bifurcation is consequently exceedingly shallow. The tubercular process turns suddenly from the shaft, and, though thin, widens out into a large concave articular surface, much larger than that of the capitulum.

There is, of course, no certainty that these vertebræ and ribs are really those of *Loxomma*; but, from their occurring in the same locality and about the same time as the cranium, we may infer that it and they came from the same part of the seam; hence the probability that they belonged to the same animal; and, moreover, the ribs differ considerably from those of *Anthracosaurus* and *Pteroplax*, the only other large Labyrinthodonts that have yet been found in the Newcastle coal-field.

MISCELLANEOUS.

The Male Prothallium of the Vascular Cryptogamia. By A. Millardet.

Our knowledge of the true nature of the functions of reproduction in plants is much less advanced than that of the functions of nutrition. Every work upon the former subjects therefore possesses great interest, especially if the author, as in the present case, rises to general considerations, and does not confine himself to the more or less minute description of certain organs. From this point of view the title of M. Millardet's memoir is too modest. After describing some new observations on the development of the microspores of the higher Cryptogamia, the author endeavours to take in at one view the whole series of phenomena of reproduction in the higher plants; and he shows how factitious are the old divisions, and how much less marked than was formerly supposed are the differences between one group and another. Without following him precisely in the arguments which he finds in this in favour of the theory of the filiation of types, we confine ourselves to regarding these extremely interesting observations as fresh proofs of the unity of the plan of creation.

In the first part of his memoir M. Millardet investigates the germination of the microspores of the genera *Marsilea*, *Pilularia*, *Isoëtes*, and *Selaginella*. He has ascertained throughout the presence of a more or less developed prothallium—a peculiarity which has escaped all other observers. In the *Marsileæ* and *Pilulariæ* this prothallium is represented physiologically rather than morphologically, if we may so speak. The antheridium, whilst becoming developed in the heart of the microspore, leaves around it a space filled with a mucilaginous liquid charged with nutritive substances. Although no cell is to be found in them, these materials evidently subserve the production of the antheridium, and thus play the part of a true prothallium. In *Isoëtes* and *Selaginella* the prothallium, although morphologically better defined, plays scarcely any physiological part. The contents of the microspore, in fact, divide into two parts, one of which, very much smaller than the other, a true vegetative cell concealed in the apex of the microspore, becomes enveloped by a membrane, and undergoes no subsequent metamorphosis. In the larger part, on the contrary, the antheridium is developed, and this, in the former of these genera, gives origin to four antherozoids only, whilst in the second it produces a much larger number.

As to the antherozoids, the author takes up a position opposed to that of Schacht. He absolutely denies their cellular nature, regards them only as modified protoplasm, and shows that the vesicle which often adheres to them has no physiological importance in the act of fecundation, and, moreover, is very often wanting. According to him, it is nothing but the residue of the protoplasmic mass placed at the centre of the mother cell, and at the expense of which the antherozoid has been developed.

In the second part of his work, M. Millardet, having ascertained the existence of a male prothallium where none was known before his researches, endeavours to bring forward the morphological importance of this fact by sketching rapidly the evolution of the principal types of the higher plants. As it has been expressed by M. Sachs, we understand by alternation of generations, or alternant generations, "the regular succession in the morphological cycle of an individual of several completely different forms, derived from so many profound changes in its mode of development." Resting upon this difinition, the author shows successively, in the different groups of the higher Cryptogamia and of the Phanerogamia, the existence of two successive generations—one sexual, the other asexual.

In the Cryptogamia the phenomenon is easily recognized. Some (Equisetaceæ, Ferns, Ophioglosseæ) are *Isosporeæ*—that is to say, only produce a single kind of spores: these in their turn produce a well-developed prothallium, furnished with chlorophyll and with roots, and consequently capable of an independent existence. On the same prothallium, or on two neighbouring ones, antheridia first of all originate; and these, when mature, emit antherozoids; then follow archegonia, generally formed of a central cell to which access is gained by a canal opening outwards. Fecundation effected, the first period is closed; and then commences the asexual generation. The embryo is developed at first in the bosom of the prothallium, but afterwards becomes disengaged from it, and passes through the different phases of its development, which we have nothing to do with here. Finally, this second generation terminates its evolution by the development of the organs of multiplication, or spores, which always originate from a normal or modified leaf.

The other Cryptogamia (Rhizocarpeæ and Lycopodiaceæ) are *Heterosporeæ*—that is to say, provided with two kinds of spores (microspore or androspore, and macrospore or gynospore). Otherwise the history of their development may be very easily referred to the plan which we have just sketched. From the two kinds of spores originate prothallia, which are frequently more or less rudimentary. Each prothallium will produce antherozoids or archegonia according to its origin. When fecundation has taken place, the second generation will commence; the embryo, at first developed in the bosom of the female prothallium, will soon live an independent life, and become a complete plant. The evolution, as in the preceding case, will conclude by the development of the spores or organs of multiplication.

The Gymnosperms form a very natural transition between the Cryptogamia and the Phanerogamia properly so called. No one will have any difficulty in identifying the anthers with the microsporangia and the grains of pollen with the microspores. The cells, from one to three in number, which are always developed in the heart of the anthers, exactly represent the prothallium; the extreme cell, from which the pollen-tube originates, will be the antheridium. At the point where the pollen-tube applies itself to the ovule, it is often possible to distinguish, in its interior, one or more primordial cells representing the last trace of the mother cells of the antherozoids.

The female organ, rather more profoundly modified, is, nevertheless, still easy to recognize. The embryonal sac, or macrospore, does not separate from the plant like the macrospores of the Cryptogamia; the embryo must, in fact, attain a degree of development much higher than in the preceding cases; it is therefore natural that it should remain adherent to the plant, especially if we consider that the prothallium or endosperm is very slightly developed.

At the moment of fecundation, or even a little before this, the endospermic cells (prothallium) fill the embryonal sac, or macrospore. At the upper part of this some of the cells are soon differentiated and become "corpuscles," which will exactly represent the archegonia. It is in their bosom that, when the proper moment arrives, the germinal cells appear, and that fecundation is effected by diffusion, the fecundating material successively traversing the membrane of the pollen-tube and that of the corpuscles.

It is here that the second period, or asexual generation, commences; and this, in the Phanerogamia, tends to acquire much greater importance than the other. In proportion as the organs which take part in the sexual generation are more degraded, those which originate by asexual generation are more numerous and perfect.

We have not the time to follow here the whole development of the embryo. We will only remark that it commences by living at the expense of the endosperm, as the Cryptogamic embryo lives at the expense of the prothallium. The development of the second generation is interrupted by a period of repose or lethargic sleep in the heart of the seed—a fact which by no means weakens the theory. When, the life of the young plant having resumed its course, it has arrived at its perfect form, it closes its biological cycle by the production of organs of multiplication corresponding to the micro- and macrospores—that is to say, the pollen- and embryonal sacs. As in the Cryptogamia, these spores are produced by modified leaves; the fact is proved as regards the stamens, and is probable at least in the case of the ovules.

Lastly, thanks to the relations which unite them with the Gymnosperms, the phenomena of reproduction of the Angiosperms may be reduced to the same general plan. The pollen-grain will still represent the microspore; only there is no longer any trace of prothallium, any more than of the mother cells of the antherozoids. The development is limited to the expansion of the *intine* in the form of a pollen-tube.

In the embryonal sac, or macrospore, no archegonia are developed; the germinal cells originate directly in its midst; but immediately after fecundation it resumes its part, and becomes the seat of the production of the endosperm or prothallium. The appearance of this, here, follows instead of preceding fecundation. The two periods are therefore less clearly limited in the Angiosperms than in other plants. They nevertheless exist; only the second, or asexual, period tends always to predominate over the sexual period, as has been indicated in the case of the Gymnosperms.

Finally the embryo is developed; and the asexual generation, as in the preceding case, is divided by a period of repose in the heart of the seed. At the end of the period of vegetation the plant always closes its biological cycle by the production of organs of multiplication; only here the modifications are more profound, and, instead of reaching only the leaf destined to produce the spores, they affect the whole upper part of the axis, and thus is formed the flower with its different whorls.

Such is the series of arguments upon which the author founds his idea of the unity of the functions of reproduction in plants—an idea, however, which he ascribes to M. Sachs, who put it forward in his 'Lehrbuch der Botanik,' published at Leipzig in 1868. Whatever value we may attach to his conclusions, this memoir of M. Millardet's possesses great interest. It is only to be regretted that the plates, which the author intends publishing hereafter in a scientific periodical, do not accompany the memoir itself.—*Notice of a work published at Strasbourg in* 1869; from *Bibl. Univ.* March 15, 1870, *Bull. Sci.* p. 275.

Morphological Researches on the Mollusca. (First Memoir: *Gasteropods.*) By M. Lacaze-Duthiers.

One of the most difficult types of the Mollusca to reduce to a theoretical plan is undoubtedly that of the Gasteropods. I propose to show that, by taking the relations of the organs and of the nervous system, it is always possible to refer the various forms to a single plan.

Let us reduce the body of the Gasteropod, for the sake of simplicity, to four parts—the *head*, the *foot*, the *visceral mass*, and the *mantle*. If we unroll the body of a species with a turbinated shell, we shall have beneath the head and behind and below the foot a reversed cone containing the viscera*.

The relations of these parts are essentially variable. Thus the head is often separated from the visceral mass by a true neck. As to the mantle, its morphology is difficult.

The study of the embryo of *Ancylus* enables us with ease to recognize this organ from its origin. In fact, upon the embryonic sphere, the head first betrays itself by the formation of the mouth. Soon two disks, bounded by a circular cushion, show themselves, the one near, the other opposite to the mouth: the former is the foot, the latter the mantle. At this moment the *Ancylus* represents the ideal being with the four principal parts.

Starting from this state, we may vary the forms and explain the modifications of the Gasteropod-type. But, in the first place, to have an exact idea of the mantle, let us suppose the embryonal disk from which it is derived eminently elastic and extensible; let us assume, further, a traction exerted upon its centre and directed backwards, and we shall obtain a reversed cone, of which the apex will be the point of application of the force of traction, and the base the part of the body bounded by the circular cushion of the primitive disk. The intestines will penetrate by traction into the cone thus formed; but the foot and the head will remain without. These four parts will be deformed, but their relations will remain constant.

It is then easy to account for some forms which are very different in appearance. For example, in the *Limaces* the foot increases

* To understand this, the animal is supposed to have the head above, the foot in front, and the apex of the spire and the mantle behind and below.